

CLAIMS

Amend the claims as follows.

Claims 1-30. (Cancelled)

31. (Currently Amended) ~~An automated~~ A method of compensating for frequency compensated communications reception including compensating for frequency offset in a received signal by adaptively forming a combination of basis functions and a training sequence that collectively approximate to, comprising:

constructing a reference signal comprising a training sequence of the received signal and one or more basis functions;

minimizing a cost function associated with the reference signal, wherein the cost function comprises the training sequence, the one or more basis functions, and the received signal; and

acquiring a desired frequency-shifted signal when the cost function indicates a predetermined degree of correlation between the reference signal and the received signal to be acquired.

32. (Currently Amended) The [[A]] method according to Claim 31, wherein a minimum cost function indicates a maximum degree of correlation between the ~~including constructing a reference signal and the received signal or comparison training sequence that is an adaptively formed combination of basis functions and the training sequence.~~

33. (Currently Amended) The [[A]] method according to Claim 32 31, ~~wherein the~~ for acquiring a signal with a receiver having multiple antenna elements, the method including constructing the reference signal by minimising a cost function further comprises constructed from an adaptively weighted combination of basis functions, a training sequence and a received signal, together with a constraint to obtain non-trivial solutions.

34. (Currently Amended) The [[A]] method according to Claim 33, wherein the constraint requires non-zero signal power.

35. (Currently Amended) The [[A]] method according to Claim 31, 33 wherein the cost function is J given by:

$J = \|Xw - CFv\|^2 + \lambda(w^H X^H X w - 1)$, wherein ~~where~~ X is a matrix of received signal samples, wherein w is a vector of beamforming weights configured ~~which are adaptive to~~ minimize ~~minimise~~ J, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, v is a vector of weights configured ~~which are adaptive to~~ minimize ~~minimise~~ J, wherein superscript index H indicates a complex conjugate transpose, and wherein λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero.

36. (Currently Amended) The [[A]] method according to Claim 35, further comprising: including

determining the ~~adaptive-weight~~ vectors w and v at intervals from ~~true~~ estimates of a correlation matrix determined from multiple data vectors and from inverses of such estimates recursively updated to reflect successive new data vectors which are rows of the matrix X.

37. (Currently Amended) The [[A]] method according to Claim 36, wherein ~~the including-recursively-updating~~ inverse correlation matrices are recursively updated by:

a) forming a vector u(n) having a first element $u_1(n)$ equal to $\sqrt{U_{1,1}(n)}$ and other elements $u_p(n)$ ($p = 2$ to M) which are respective ratios $U_{p,1}(n)/u_1(n)$, $U_{p,1}(n)$ is a pth element of a first column of a matrix U(n), wherein the matrix $U(n) = u(n)u^H(n) = x(n)x^H(n) - x(n - K + 1)x^H(n - K + 1)$, wherein x(n) is a most recent data vector, and wherein $x(n - K + 1)$ is a least recent data vector involved in updating, and wherein $x(n)x^H(n)$ and $x(n - K + 1)x^H(n - K + 1)$ are correlation matrices;

b) premultiplying a previous inverse correlation matrix $P(n - 1)$ by vector $u^H(n)$ and postmultiplied by vector u(n) to form a product; and

adding the product to a forget factor to form a sum;

e) ~~postmultiplying the previous inverse correlation matrix $P(n-1)$ by vector $u(n)$ to form a second product; and~~
 dividing the second product by the said sum to form a quotient; and
 d) ~~subtracting the quotient from the previous inverse correlation matrix $P(n-1)$ to provide a difference.~~

38. (Currently Amended) The [[A]] method according to Claim 31, wherein the received signal is acquired by 32 for acquiring a signal with a receiver having a single antenna element, the method including constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a scaled received signal and a constraint requiring non-zero signal power.

39. (Currently Amended) The [[A]] method according to Claim 38, wherein the cost function is J given by:

$J = \|x - CFv\|^2$, wherein where x is a vector of received signal samples, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, and wherein v is a vector of weights configured to minimize J and v, C and F are as defined earlier.

40. (Currently Amended) The [[A]] method according to Claim 38, wherein the cost function is J given by:

$J = \|\alpha x - Gv\|^2 + \lambda(\alpha^H x \alpha - 1)$, wherein where α is a scaling factor, wherein x is a vector of received signal samples, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, wherein G is a matrix equal to CF, wherein v is a vector of weights configured to minimize J, wherein superscript index H indicates a complex conjugate transpose, and wherein λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero and v, λ , C, F and H are as defined earlier.

41. (Currently Amended) An Apparatus configured to compensate for frequency compensated communications reception including means for compensating for frequency offset in a received signal, wherein the apparatus comprises:

means for constructing a reference signal comprising one or more by adaptively forming a combination of basis functions and a training sequence, wherein the means for constructing the reference signal is configured to minimize a cost function comprising the one or more basis functions, the training sequence, and the received signal; and

means for acquiring that collectively approximate to a desired frequency-shifted signal when the cost function indicates a predetermined degree of correlation between the reference signal and the received signal to be acquired.

42. (Cancelled)

43. (Currently Amended) The Apparatus according to Claim 42 having a receiver with 41, wherein the means for acquiring comprises multiple antenna elements for acquiring the received signal, the apparatus including means for constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a training sequence and a received signal, together with a constraint to obtain non-trivial solutions.

44. (Currently Amended) The Apparatus according to Claim 43, wherein the cost function further comprises a constraint to obtain non-trivial solution, and wherein the constraint requires non-zero signal power.

45. (Currently Amended) The Apparatus according to Claim 43 41, wherein the cost function is J given by:

$J = \|Xw - CFv\|^2 + \lambda(w^H X^H X w - 1)$, wherein where X is a matrix of received signal samples, wherein w is a vector of beamforming weights configured which are adaptive to minimize minimise J, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, v is a vector of weights configured which are adaptive to minimize minimise J, wherein superscript index H indicates a complex conjugate transpose, and wherein λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero.

46. (Currently Amended) The Apparatus according to Claim 45, further comprising: including

means for determining the adaptive-weight vectors w and v at intervals from true estimates of a correlation matrix determined from multiple data vectors and from inverses of such estimates recursively updated to reflect successive new data vectors which are rows of the matrix X .

47. (Currently Amended) The Apparatus according to Claim 46 45, further comprising including means for recursively updating inverse correlation matrices by:

a)-forming a vector $u(n)$ having a first element $u_1(n)$ equal to $\sqrt{U_{1,1}(n)}$ and other elements $u_p(n)$ ($p=2$ to M) which are respective ratios $U_{p,1}(n)/u_1(n)$, $U_{p,1}(n)$ is a p th element of a first column of a matrix $U(n)$, wherein the matrix $U(n) = u(n)u^H(n) = x(n)x^H(n) - x(n-K+1)x^H(n-K+1)$, wherein $x(n)$ is a most recent data vector, and wherein $x(n-K+1)$ is a least recent data vector involved in updating, and wherein $x(n)x^H(n)$ and $x(n-K+1)x^H(n-K+1)$ are correlation matrices;

b)-premultiplying a previous inverse correlation matrix $P(n-1)$ by vector $u^H(n)$ and postmultiplied by vector $u(n)$ to form a product; and

adding the product to a forget factor to form a sum;

c)-postmultiplying the previous inverse correlation matrix $P(n-1)$ by vector $u(n)$ to form a second product; and

dividing the second product by the said sum to form a quotient; and

d)-subtracting the quotient from the previous inverse correlation matrix $P(n-1)$ to provide a difference.

48. (Currently Amended) The Apparatus according to Claim 42 having a receiver with 41, wherein the means for acquiring comprises a single antenna element, and wherein the single antenna is configured to product a single output signal for any given sample time for acquiring the received signal, the apparatus including means for constructing the reference signal by minimising a cost function constructed from an adaptively-weighted combination of basis functions, a scaled received signal and a constraint requiring non-zero signal power.

49. (Currently Amended) The Apparatus according to Claim 48 41, wherein the cost function is J given by:

$J = \|x - CFv\|^2$, wherein where x is a vector of received signal samples, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, and wherein v is a vector of weights configured to minimize J and v, C and F are as defined earlier.

50. (Currently Amended) The Apparatus according to Claim 48 41, wherein the cost function is J given by:

$J = \|ax - Gv\|^2 + \lambda(\alpha * x^H x \alpha - 1)$, wherein where α is a scaling factor, wherein x is a vector of received signal samples, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, wherein G is a matrix equal to CF, wherein v is a vector of weights configured to minimize J, wherein superscript index H indicates a complex conjugate transpose, and wherein λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero and v, λ , C, F and H are as defined earlier.

51. (Currently Amended) A computer-readable medium having stored thereon, computer-executable instructions that, if executed by a system, cause the system to perform a method comprising: computer software product comprising a computer readable medium containing computer readable instructions for controlling operation of computer apparatus for use in frequency compensated communications reception; wherein the computer readable instructions provide a means for controlling the computer apparatus to compensate for frequency offset in a received signal by adaptively forming a combination of basis functions and a training sequence that collectively approximate to constructing a reference signal comprising an original training sequence and a plurality of sinusoidal basis functions;

minimizing a cost function associated with the reference signal, wherein the cost function comprises the original training sequence, the plurality of basis functions, and a received signal; and

acquiring a desired frequency-shifted signal when the cost function indicates a predetermined degree of correlation between the reference signal and the received signal to be acquired.

52. (Currently Amended) The computer-readable medium A computer software product according to Claim 51, wherein the method further comprises: computer readable instructions provide a means for

constructing a reference signal or comparison training sequence that is an adaptively formed combination of the basis functions and the original training sequence.

53. (Currently Amended) The computer-readable medium A computer software product according to Claim 51, wherein the 52 for use in processing received signals acquired by a receiver with multiple antenna elements, wherein the computer readable instructions provide a means for for constructing the reference signal by minimising a cost function further comprises constructed from an adaptively weighted combination of basis functions, a training sequence and a received signal, together with a constraint to obtain non-trivial solutions, and wherein the constraint requires non-zero signal power.

54. (Cancelled)

55. (Currently Amended) The computer-readable medium A computer software product according to Claim 53 51, wherein the cost function is J given by:

$J = \|Xw - CFv\|^2 + \lambda(w^H X^H X w - 1)$, wherein where X is a matrix of received signal samples, wherein w is a vector of beamforming weights configured which are adaptive to minimize minimise J, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, v is a vector of weights configured which are adaptive to minimize minimise J, wherein superscript index H indicates a complex conjugate transpose, and wherein λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero.

56. (Currently Amended) The computer-readable medium ~~A computer software product~~ according to Claim 55, wherein the method further comprises: ~~computer readable instructions provide a means for~~

determining the ~~adaptive-weight~~ vectors w and v at intervals from ~~true~~ estimates of a correlation matrix determined from multiple data vectors and from inverses of such estimates recursively updated to reflect successive new data vectors which are rows of the matrix X .

57. (Currently Amended) The computer-readable medium ~~A computer software product~~ according to Claim ~~56~~ 55, wherein the method further comprises ~~computer readable instructions provide a means for~~ recursively updating inverse correlation matrices by:

a)-forming a vector $u(n)$ having a first element $u_1(n)$ equal to $\sqrt{U_{1,1}(n)}$ and other elements $u_p(n)$ ($p=2$ to M) which are respective ratios $U_{p,1}(n)/u_1(n)$, $U_{p,1}(n)$ is a p th element of a first column of a matrix $U(n)$, wherein the matrix $U(n) = u(n)u^H(n) = x(n)x^H(n) - x(n-K+1)x^H(n-K+1)$, wherein $x(n)$ is a most recent data vector, and wherein $x(n-K+1)$ is a least recent data vector involved in updating, and wherein $x(n)x^H(n)$ and $x(n-K+1)x^H(n-K+1)$ are correlation matrices;

b)-premultiplying a previous inverse correlation matrix $P(n-1)$ by vector $u^H(n)$ and postmultiplied by vector $u(n)$ to form a product; and

adding the product to a forget factor to form a sum;

c)-postmultiplying the previous inverse correlation matrix $P(n-1)$ by vector $u(n)$ to form a second product; and

dividing the second product by the said sum to form a quotient; and

d)-subtracting the quotient from the previous inverse correlation matrix $P(n-1)$ to provide a difference.

58. (Currently Amended) The computer-readable medium ~~A computer software product~~ according to Claim 51, wherein the ~~52 for use in processing received signal is~~ signals acquired by a receiver comprising ~~with~~ a single antenna element; wherein the computer readable instructions provide a means for constructing the reference signal by minimising a cost function constructed from an adaptively weighted

~~combination of basis functions, a scaled received signal and a constraint requiring non-zero signal power.~~

59. (Currently Amended) ~~The computer-readable medium A-computer software product according to Claim 58, wherein the cost function is J given by:~~

$J = \|x - CFv\|^2$, ~~wherein where~~ x is a vector of received signal samples, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, and wherein v is a vector of weights configured to minimize J and v, C and F are as defined earlier.

60. (Currently Amended) ~~The computer-readable medium A-computer software product according to Claim 58, wherein the cost function is J given by:~~

$J = \|ax - Gv\|^2 + \lambda(a^H x a - 1)$, ~~wherein where~~ a is a scaling factor, wherein x is a vector of received signal samples, wherein C is a diagonal matrix having elements of the training sequence on its diagonal, wherein F is a matrix having columns defining respective basis functions, wherein G is a matrix equal to CF, wherein v is a vector of weights configured to minimize J, wherein superscript index H indicates a complex conjugate transpose, and wherein λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero and v, λ , C, F and H are as defined earlier.

61. (New) The method according to Claim 31, wherein the one or more basis functions comprise a sinusoid.

62. (New) The apparatus according to Claim 42, wherein the one or more basis span a subspace in which a complex sinusoid associated with the frequency offset lies.